

SOME MORPHOLOGICAL AIDS IN DISTINGUISHING  
NUPHAR MICROPHYLLUM  
FROM SIMILAR AQUATICS

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This study is an outgrowth of my recent discovery that a specimen of *Nuphar microphyllum* (Pers.) Fern in the University of New Hampshire Herbarium had been erroneously labelled *Nymphoides cordata* (Ell.) Fern because of the apparently identical macroscopic appearance of the small floating leaves despite the presence of filmy submersed foliage characteristic of *Nuphar*. This specimen, collected in Adams Pond in Pittsfield, N. H., constitutes a first record for Merrimack County and, more significantly, represents the most southern collection point in the state known at the present time. *Nuphar microphyllum* occurs generally in Maine and in Massachusetts, and to a more limited extent in Vermont and Connecticut, but has been reported in New Hampshire only in Coös and Carroll counties according to F. C. Seymour (1969). Research at the Gray Herbarium yielded two specimens from the same locality in Hanover in Grafton County in the early 1900's; and, more recently, C. Barre Hellquist has added another Grafton County station at Lily Pond in Livermore. Perhaps New Hampshire ponds have not been as thoroughly botanized as have those in Maine, Vermont and Massachusetts. Future investigation may disclose the fact that *N. microphyllum* occurs more frequently, if not much more abundantly, in the state than has heretofore been suspected.

The pH and alkalinity of ponds sometimes affect the distribution of species. Professor Hellquist kindly furnished readings taken by him at some ponds where *Nuphar microphyllum* occurs in Maine, Vermont and in Coös, Carroll and Grafton counties in New Hampshire. In New Hampshire the pH ranges from 6.0 to 6.7 whereas in Maine and Vermont, pH values are generally in the 7 range up to 7.9. The alkalinity readings for New Hampshire run from 2.5

ppm to 9.0 ppm of carbonates and bicarbonates but are considerably higher, 9.0 ppm to 60.0 ppm, in Vermont and Maine. The above limited data seem to indicate that *N. microphyllum* is adapted to a pH close to neutral and tolerates a wide range of alkalinity. Perhaps the more acidic waters of New Hampshire ponds and the lower concentration of carbonates and bicarbonates do not favor growth of this species.

Seymour lists not only Coös and Carroll counties but also Cheshire County for *Nuphar* × *rubrodiscum* Morong, a fertile hybrid between *N. variegatum* Engelm. and *N. microphyllum*. In the light of the Grafton County records of *N. microphyllum* cited above and the Merrimack County record reported in this paper, it would seem plausible that hybridization could have occurred in these counties although no hybrids have as yet been reported. Examination of the Cheshire County specimens, one each in the Gray and New England Botanical Club herbaria from Gilmore Pond in Jaffrey in 1897, revealed them to truly be *N.* × *rubrodiscum* according to both the author and A. R. Hodgdon. Although it has not yet been reported, one would expect to find *N. microphyllum*, one of the parents, in the county and possibly in the same pond. When and if it is discovered, it will constitute the southernmost record for the state. However, as the two Jaffrey specimens were collected prior to 1900, it is conceivable that the species could have since disappeared.

It is sometimes difficult to differentiate the hybrid from either parent as the range of parental characteristics is a broad one in regard to such morphological features as the size of the leaf, the diameter of the petiole and the size of the flower. Figure 1A, a comparison of the minimum and maximum lengths of the floating leaves in the three species as indicated in current manual descriptions, shows a considerable overlap which makes identification troublesome, if not impossible, on the basis of leaf size alone. It is then advisable to examine the diameter of the petiole as shown in figure 1B. The petioles of *Nuphar microphyllum* leaves

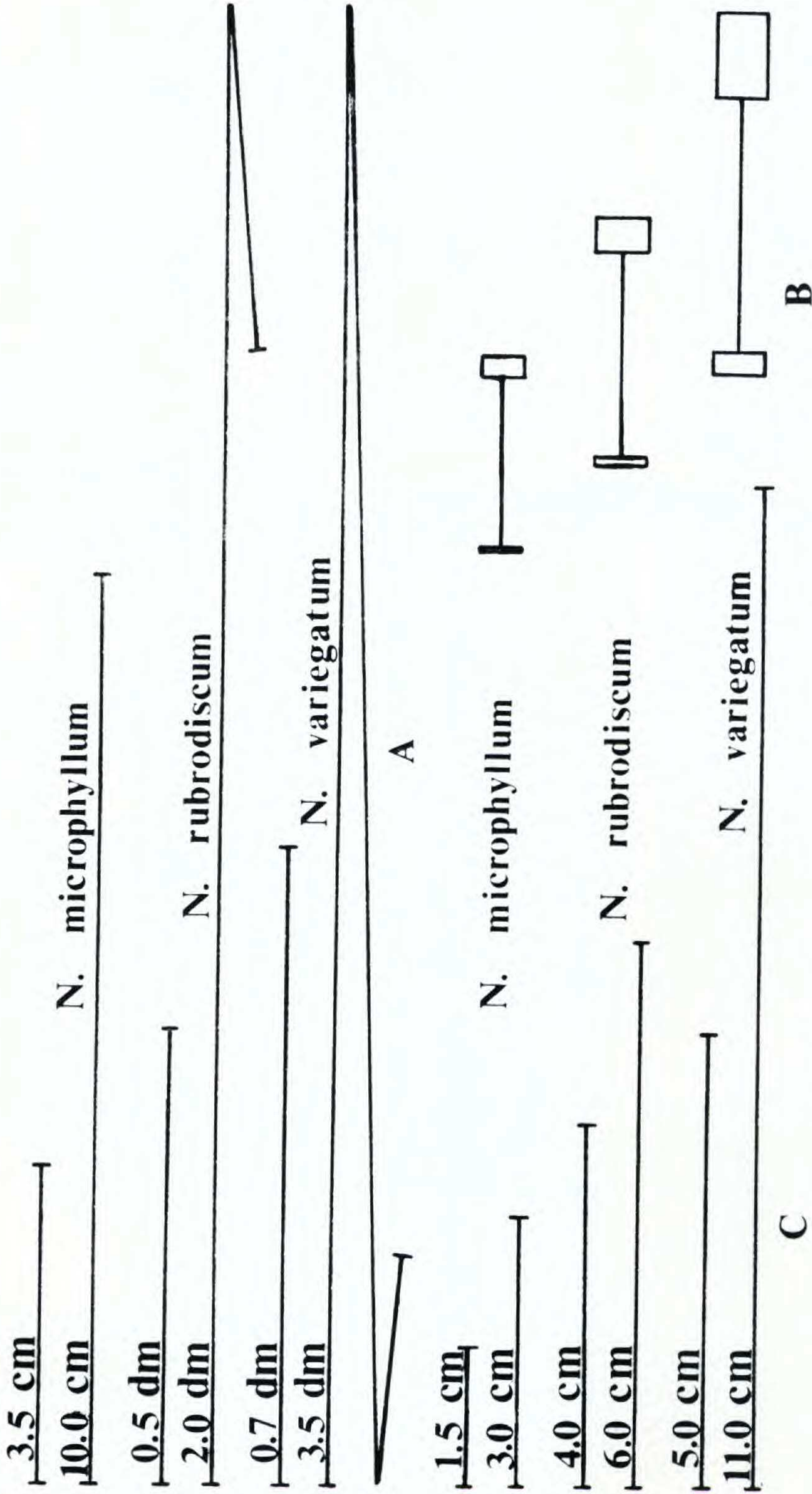


Figure 1: A. Comparative minimum and maximum lengths of the floating leaves of *Nuphar*. B. Comparative diameters of petioles of *Nuphar*. C. Comparative minimum and maximum widths of flowers of *Nuphar*. All dimensions are actual size.

are markedly filiform. Careful measurement of petioles of all three species in the New England Botanical Club Herbarium indicated a significant overlapping of petiole diameters. A specimen with a leaf and petiole within the size range of both *N. microphyllum* and *N. × rubrodiscum* would still be puzzling. The final recourse then is to the flower or fruit. Figure 1C illustrates the comparative widths of the flowers of the three species when laid open, following dimensions given in *Gray's Manual*. For the first time, there is no overlap between *N. microphyllum* and *N. × rubrodiscum*. Furthermore, the petals and stamens of the flower of *N. microphyllum* are promptly deciduous whereas, in the other two species, they persist at the base of the young fruit. I examined the specimens of all three species in the New England Botanical Club Herbarium and, with the approval of A. R. Hodgdon, reannotated four of them. Two were transferred from *N. microphyllum* to *N. × rubrodiscum* and two were changed from *N. variegatum*, one each to *N. microphyllum* and *N. × rubrodiscum*.

The genus *Nuphar* is characterized by dimorphic leaves: filmy, undulate submersed leaves and the well known firmer floating leaves. In his descriptions of the three species of *Nuphar*, Fernald (1950) mentions only *N. microphyllum* as possessing filmy submersed leaves. Fassett (1966) fails to note the presence of this foliage in any of the three species. It is of interest that Otto Brunfels in 1530 in his illustrated herbal, *Herbarium Vivae Eicones*, included a drawing of *Nuphar luteum*, a European species, depicting both types of foliage.

The thin submersed leaves tend to disappear in *Nuphar variegatum* as the plant grows larger and older whereas they generally seem to persist in *N. microphyllum* (figure 2A) and to a lesser degree in the hybrid, *N. × rubrodiscum*. Perhaps their persistence in *N. microphyllum* accounts for their being mentioned by Fernald. These observations are based on a study of the New England Botanical Club specimens: of 23 specimens of *N. microphyllum* with

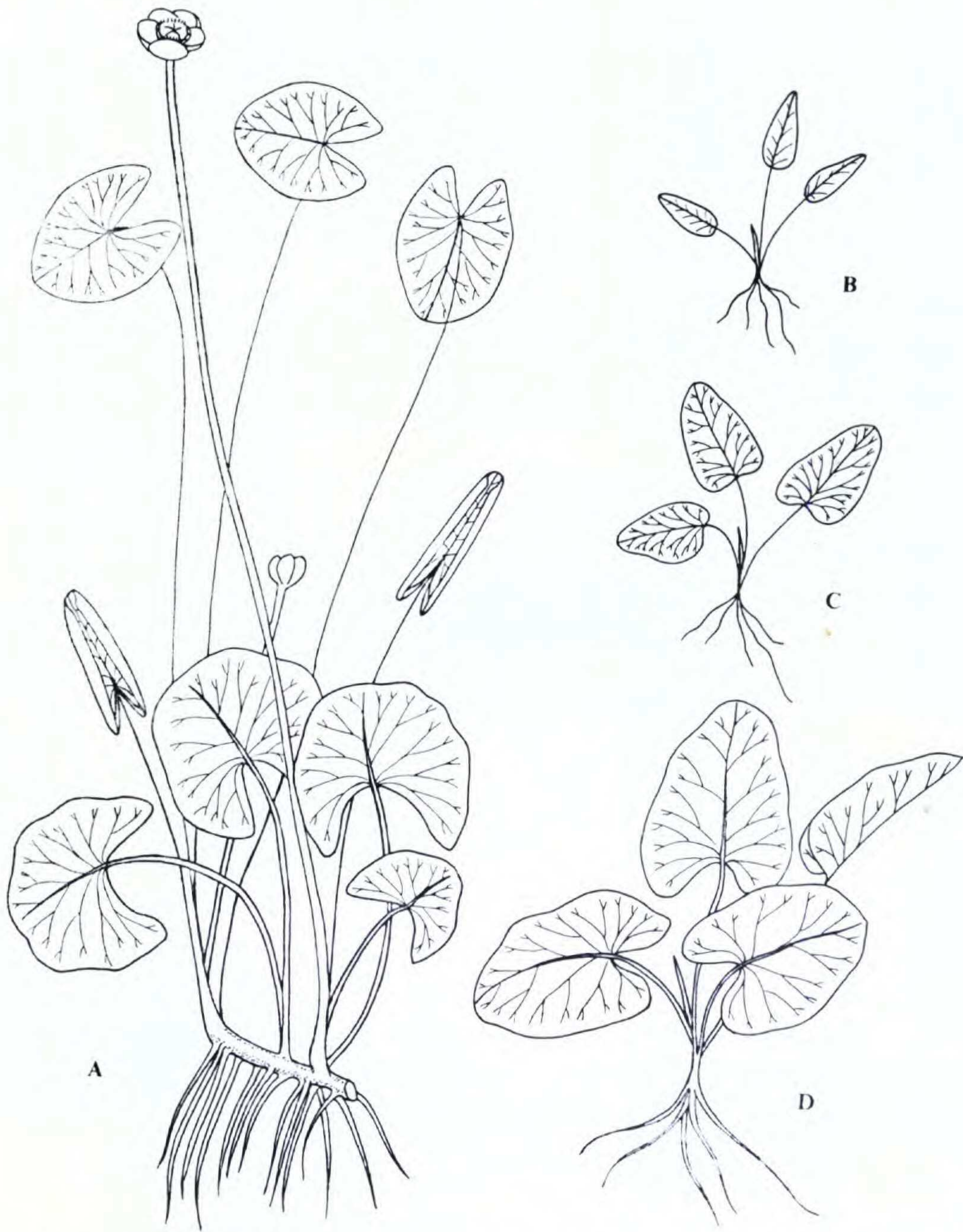


Figure 2: A. *Nuphar microphyllum* habit  $\times \frac{1}{4}$ . B, C, D. *Nuphar variegatum*, seedling stages  $\times \frac{1}{4}$ .

basal parts, 19 have filmy submersed foliage; of 11 specimens of *N. × rubrodiscum*, 7 have filmy leaves; of eight folders of *N. variegatum* containing a great many specimens, only 3 sheets have this foliage.

The seedlings of all three species have membranaceous foliage with filiform petioles (figure 2B, C, D). It would require careful observation to distinguish between the three species in the seedling stage. Determination of species could possibly be made on the basis of seedling size if the seeds of each species are of different sizes which has yet to be established. The size of seedlings, however, could be confounded by variability in age. One way to solve this problem would be to germinate seeds of each species and to observe differences in size of seedlings with age as a control factor. However this procedure, while of value under controlled conditions, would not shed much light on relative age and size in the field. Perhaps the location of a seedling could indicate its species although in mixed colonies this criterion would be inadequate. While examining specimens of *Nymphoides cordata* in the New England Botanical Club Herbarium, I found a sheet of *Nuphar* seedlings, possibly those of *N. microphyllum*, labelled as seedlings of *Nymphoides*.

*Nuphar microphyllum*, as shown in figure 2A, appears to be a composite of a *Nuphar* seedling with attached floating leaves of *Nymphoides cordata*. The close resemblance between the floating leaves of *N. microphyllum* and those of *Nymphoides* in regard to both size and shape is startling and can lead to a confusion of the two species especially when underwater foliage is not present and when *Nymphoides* lacks the characteristic cluster of thick roots on the petiole just below the surface of the water. Figure 3 shows the similarity in shape between the floating leaves of the two species as well as the variability within each species. These are reduced leaf tracings from herbarium specimens. The shape and width of the sinus show remarkable variation. Some specimens of *N. microphyllum* exhibit a wide V-shaped sinus while others have a very

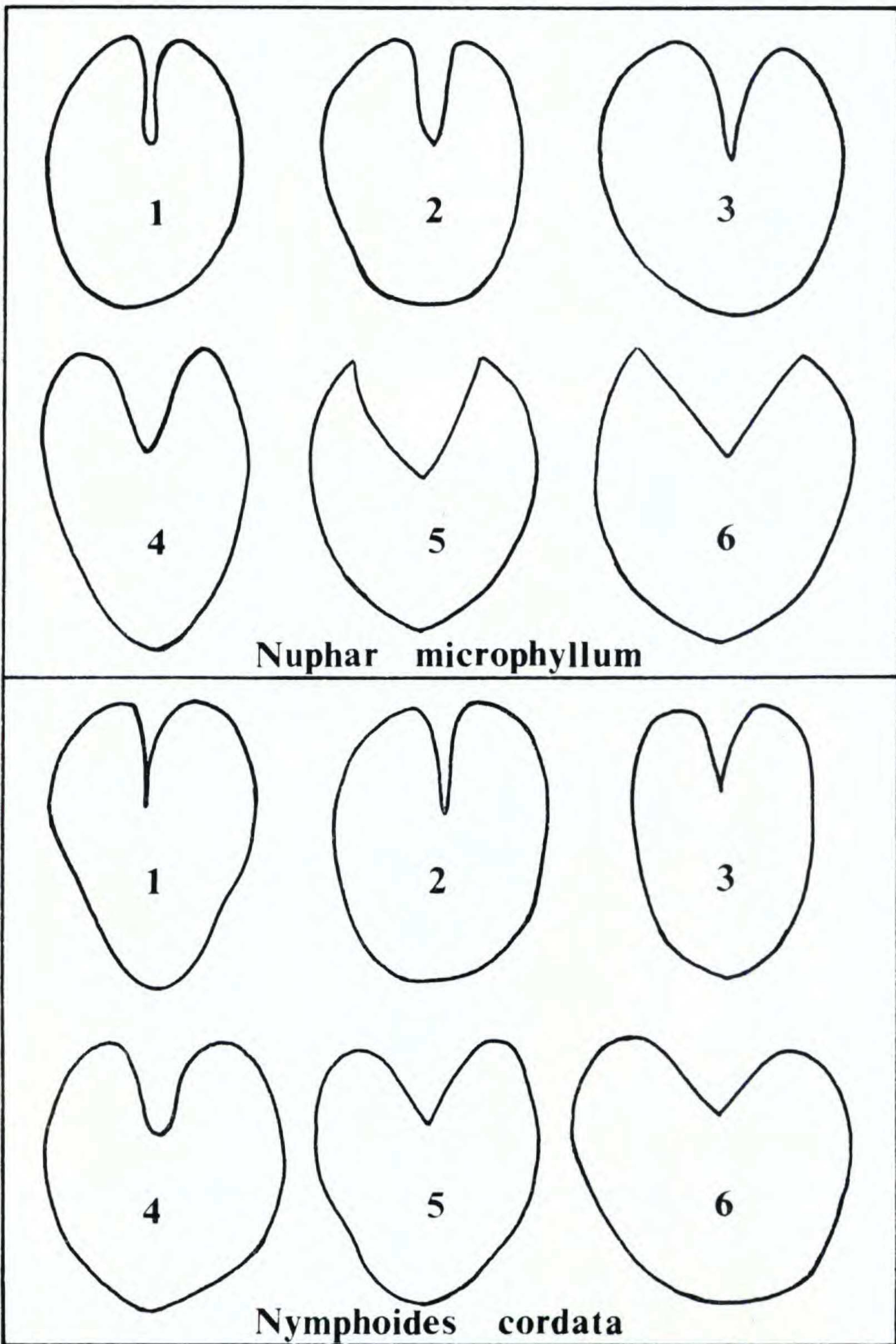


Figure 3. Similarity and variability in leaf shape of the floating leaves of *Nuphar microphyllum* and *Nymphoides cordata*.

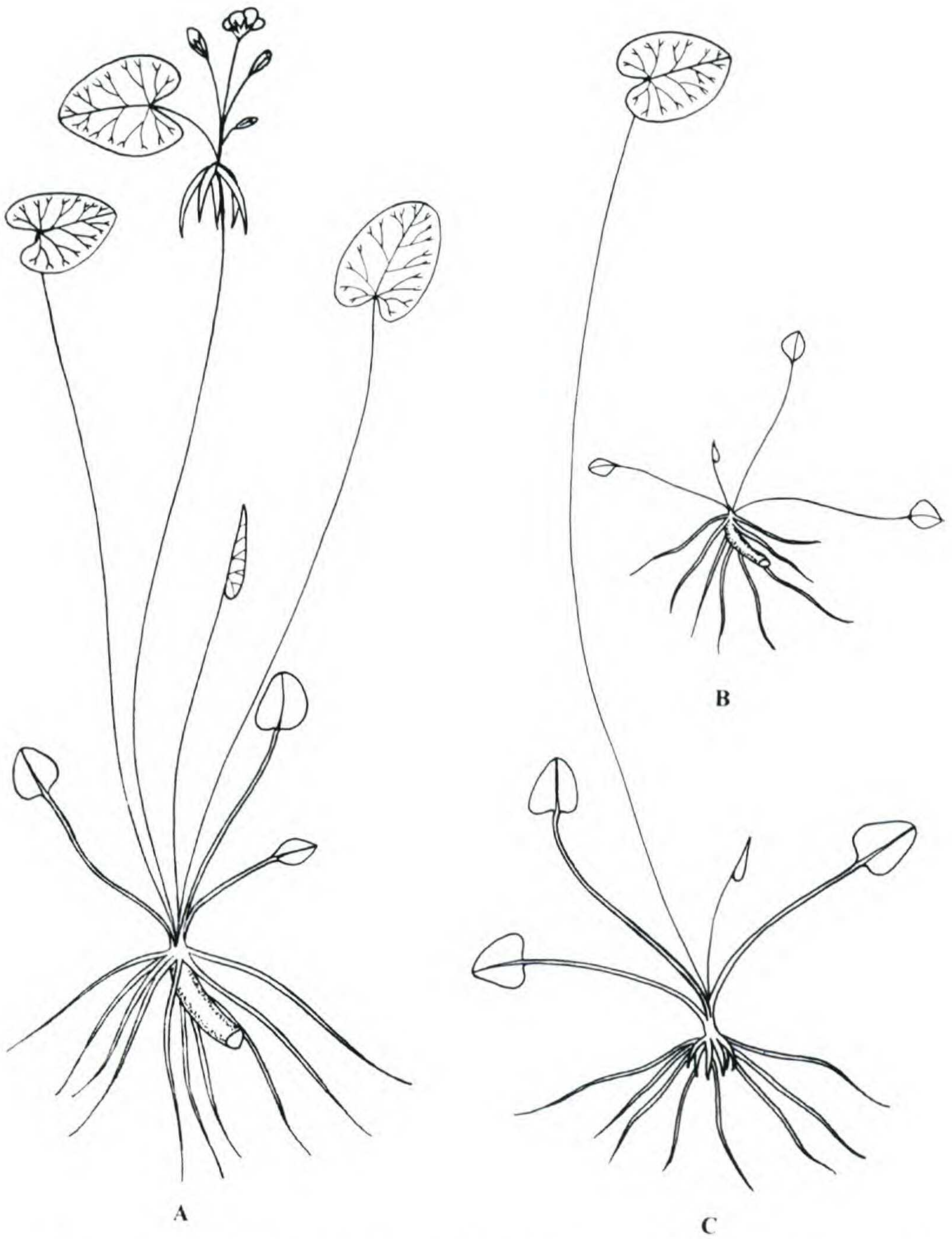


Figure 4: A. *Nymphoides cordata*, habit  $\times \frac{1}{2}$ . B. Seedling  $\times \frac{1}{2}$ . C. Young plant  $\times \frac{1}{2}$ .



narrow sinus with almost parallel sides. The shape of the sinus of the floating leaves is similar to that of the submersed foliage on the same plant.

*Nymphoides cordata* also possesses dimorphic leaves. In addition to the floating cordate leaves, the plant has smaller rhombic submersed leaves characteristic of the seedling stage and of the young plant (figure 4A). The illustration of the seedling (figure 4B) depicts the generation of a new plant from the rhizome whereas the drawing of the young plant (figure 4C) seems to indicate that a new individual can also arise by vegetative propagation from the detachment, submergence and subsequent rooting of a leaf and petiole with its group of thickened roots. The underwater leaves are absent in many, but not all, of the specimens studied. Their frequent absence in more mature plants may account for the fact that neither Fernald nor Fassett mentions these submersed leaves in their descriptions of the species. Drawings of *Nymphoides* in both Fassett's book and in that of N. Hotchkiss (1967) have no basal parts, only the floating leaf and the short, spur-like thickened cluster of roots attached to the petiole at which point the flowers arise.

In conclusion, it is sometimes difficult to distinguish *Nuphar microphyllum* from other similar aquatic plants. When the entire plant including the floating leaves, filmy submersed leaves, flower or fruit are present, it cannot be mistaken for *Nymphoides cordata*; if only the floating leaves and submersed foliage are present, it could be confused with *N. × rubrodiscum*; when only the floating leaves are evident, it could be taken for either *N. × rubrodiscum* or *Nymphoides*. This confusion points out the desirability of collecting as complete specimens as possible.

The illustrations were prepared by the author from specimens in the University of New Hampshire Herbarium (NHA) from localities in Maine and New Hampshire.

I greatly appreciate the privilege of using the New England Botanical Club and Gray herbaria without which this study would have been impossible.

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